ISO 9001:2015 CERTIFIED
BROOKFIELD AMETEK

POWDER ANALYSIS APPLICATION NOTE:

Baking Soda

USE

Many household uses: baking and cleaning.

TEST EQUIPMENT

Instrument:	Powder Flow Tester (PFT)
Trough:	230 cc, 6-inch diameter (Standard Volume)
Lid Type:	Vane Lid, 33cc, 6-inch diameter
	Wall Lid, 2B finish, 6-inch diameter
Type of Test:	Flow Function Test, Wall Friction Test
Temperature:	Room Temperature (70-72°F)
Humidity:	48%

TEST METHOD

A Brookfield Powder Flow Tester, equipped with Powder Flow Pro software for automated instrument control and data acquisition, was used to test this name brand baking soda. The baking soda was scooped into the trough, and the scraping tool was then used to evenly distribute the powder throughout the trough. After recording the sample weight and entering it into the software, a standard flow function test and then a wall friction test were run. Time required for each test was 25 minutes and 13 minutes respectively.

PARAMETERS MEASURED

Flowability: Very Cohesive to Cohesive
Wall Friction: 35° to 27°
Bulk Density: 1000 kg/m^3 (fill density) to 1000 kg/m^3

ANALYSIS

Hopper Shape:	Conical
Arching Flow Factor:	1.40
Critical Arching Dimension:	90.2 mm (3.55 in.)
Rat-hole Diameter:	Dependent on bin diameter

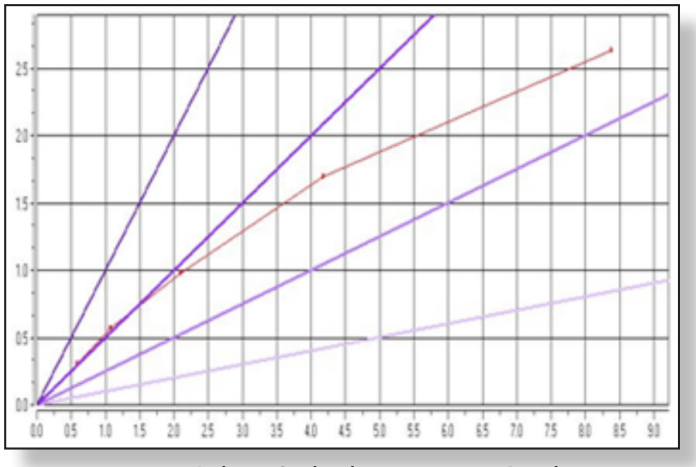

Figure 1: Baking Soda Flow Function Graph

RESULTS

Figure 1 shows the flowability of the baking soda at different levels of consolidating stress. These results show that the baking soda is generally cohesive except at very low levels of consolidating stress where it begins to fall into the very cohesive range (below 1.5 kPa).

Note: The Flow Function data is indicated by the red line. The other lines are references (or "Standard Flow Indices"), which distinguish the different types of flow behavior, ranging from "non-flowing" to "free flowing".

Figure 2 represents the angles of wall friction at different levels of normal stress. Angles of wall friction represent the friction between the sliding powder and the wall of the hopper or chute at the onset of flow. In

this test a stainless steel lid was used, illustrating what the friction would be like if the baking soda was in a stainless steel hopper. At a low normal stress of about 0.5 kPa, the effective angle of wall friction is about 35° and goes down to about 27° at higher levels of normal stress (4.75 kPa).

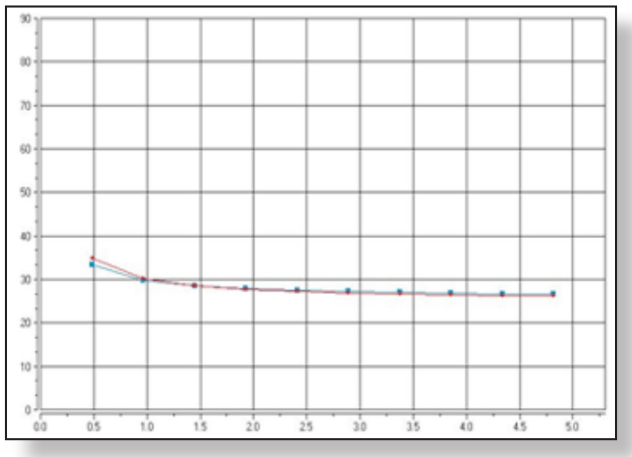

Figure 2: Baking Soda Wall Friction Graph

Figure 3 shows the bulk density of the material at different levels of consolidating stress. This graph tells us that the baking soda has a fill density of about 1000 kg/m^3 and rises to about 1100 kg/m^3 at around 4.5 kPa of consolidating stress. In general, a free flowing powder will show very small changes in bulk density, while a cohesive or poor flowing powder will generally show a large increase in bulk density.

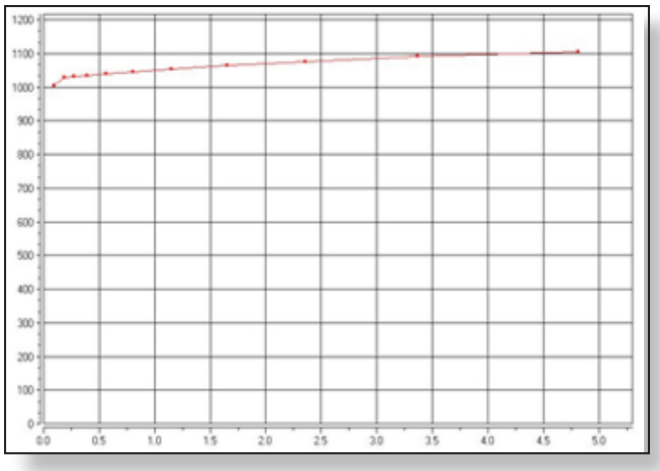

Figure 3: Baking Soda Bulk Density Graph

CONCLUSION

The baking soda is a very cohesive powder at low consolidation stress levels and cohesive at high consolidation stress levels. This means that the baking soda may have flowability issues as the hopper empties. Possible problems include arching (when the powder forms a cohesive bridge over the outlet) and rat-holing (when the powder flows out only from the center leaving the rest of the material static against the walls). The critical arching dimension, of 3.55 inches (90.2 mm) provides a conservative estimate to prevent arching from happening, provided the minimum outlet dimension of the hopper exceeds this value. The critical rat-holing dimension is dependent on the diameter of the bin. The rat-hole diameter can be automatically calculated by Powder Flow Pro once the bin diameter is entered.